

Assessing The Limits of Synthetic Controls:

On the Estimation of Causal Effects in Time Series Data Structures

Lennart Boldwin¹, Justus Töhns²

^{1,2} University of Cologne, Chair of Statistics and Econometrics
Supervised by Prof. Jörg Breitung

Abstract

Potential framework: We argue that applications of Synthetic Controls (SC) are faced with a self-selection problem. That is, the method is primarily applied to non-complex data structures that are straightforward to forecast, given the availability of donors in the post-treatment period. Using Monte Carlo studies, we show that the high interpretability of SC comes at the costs of poor predictions and forecasts, which are especially pronounced if the data generating process contains a time series structure. To address this issue, we introduce the intricacy-statistics that informs the applied researcher whether or not the data at hand exceeds a level of time series structure that SC can handle. If the case, more flexible methodologies that combine the strengths of SC and conventional time series techniques promise more accurate predictions and forecasts. Hence we introduce the new VAR-SC estimator, that takes in account both the time series structure and the availability of donors. In order to implement these ideas, we introduce the R-package `complex_synths` that provides ready-to-use functions to compute the intricacy-statistics and, based on the magnitude of the statistics, the functionalities to estimate either the SC or the VAR-SC model. To probe the performance of our methodology outside the experimental setting, we apply it to existing application of SC and to a highly complex data structure: The inclusion of a stock in an index. Specifically, we find that the inclusion of the German multi-national eCommerce company Zalando in the German stock index (DAX) caused an excess capitalization of XXX milion euro.

Keywords: *Causality; Enjoy Machine Learning*

1. Introduction

The method of Synthetic Controls (SC) is cool.

2. Literature Review 2-3 pages

2.1. Synthetic Control

The Synthetic Control (SC) method was developed by Alberto Abadie and Javier Gardeazabal in 2003 ([Abadie and Gardeazabal, 2003]). In their canonical article, the two scholars assess the causal economic effects of conflict, using terrorist conflicts in the Basque Country as a comparative case study. Combining aspects of the matching and difference-in-difference literature, Abadie and Gardeazabal invent the SC method, which allows social scientists to estimate the causal treatment effect of interventions in observational studies.

[Abadie et al., 2007] read.

[Abadie et al., 2015] read.

2.2. Overview

[Abadie, 2021] read.

[Athey and Imbens, 2016] read.

2.3. Application

[Born et al., 2019] read.

[Cho, 2020] read.

[Cunningham, 2021] read.

[Funke et al., 2020] read.

2.4. Methodological Background

[Hainmueller et al., 2011] read.

[Abadie and Imbens, 2006] not read.

[Abadie and Imbens, 2002] not read.

[Doudchenko and Imbens, 2016]

[Ferman, 2021] read.

[Frangakis and Rubin, 2002] not read.

[Rosenbaum and Rubin, 1983] not read

[Rubin, 1974] not read.

2.5. Extensions/ Developments

[Abadie and L'Hour, 2021] read.

[Amjad et al., 2018] read.

[Ben-Michael et al., 2021] read.

[Ben-Michael et al., 2021] not read.

[Kellogg et al., 2021] not read.

[Kuusmanen et al., 2021] not read.

[Muhlbach and Nielsen, 2019] read.

Developments

[Arkhangelsky et al., 2021] not read

[Athey et al., 2017] not read.

[Brodersen et al., 2015] read.

[von Brzeski et al., 2015] read.

[Hartford et al., 2017] read.

2.6. Testing

[Andrews, 2003] not read.

[Cattaneo et al., 2021] not read.

[Chernozhukov et al., 2019] not read.
[Chernozhukov et al., 2021] not read.
[Firpo and Possebom, 2018] not read.
[Hahn and Shi, 2017] read.

2.7. Time Series Econometrics

[Martin et al., 2012] read.
[Harvey and Thiele, 2020] read.
[Breitung and Knüppel, 2021] partially read.

3. Theory (10pt, bold)

4. **Simulation Study (10pt, bold)**

some text

5. Applications (if any)

6. Conclusion

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